SMART PARKING SYSTEM USING IOT

A Dissertation Submitted for partial fulfillment of the Requirements for the Award of the Degree of Bachelor of Computer Application in 2023

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Submitted by

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CERTIFICATE OF APPROVAL

This is to certify that the final year Bachelor of Computer Applications (BCA) project entitled "SMART PARKING SYSTEM USING IOT carried out by BIPASHA GOSWAMI with ADTU/2020-23/BCA/006, GUNJAN ROY with ADTU/2020-23/BCA/009 and TARIFA AHMED with ADTU/2020-23/BCA/024 have been successfully completed and approved by the undersigned as a requirement for the fulfillment of the Bachelor of Computer Applications degree from Assam Down Town University.

The project was evaluated based on its originality, technical complexity, execution, and overall contribution to the field of Computer Applications. The work presented by the students demonstrates a commendable level of proficiency and understanding of the subject matter.

I, therefore, endorse and recommend the acceptance and approval of this project for the fulfillment of the Bachelor of Computer Applications degree from Assam Down Town University.

Date:

_____

Dr. Utpal Barman
Dean, Faculty of Computer Technology
Assam Down Town University
Panikhaiti, Guwahati-781026

ETHICAL CLEARANCE CIRTIFICATE

This is to certify that the final year Bachelor of Computer Applications (BCA) project entitled "SMART PARKING SYSTEM USING IOT" carried out by BIPASHA GOSWAMI with ADTU/2020-23/BCA/006, GUNJAN ROY with ADTU/2020-23/BCA/009 and TARIFA AHMED with ADTU/2020-23/BCA/024 have received ethical clearance from the appropriate authorities to ensure compliance with ethical standards and guidelines set by Assam Down Town University and relevant regulatory bodies.

The ethical clearance process involved a comprehensive review of the project proposal, including its objectives, methodologies, and potential ethical implications. The project was evaluated to ensure adherence to principles such as confidentiality, informed consent, data protection, and fairness.

After careful consideration, it has been determined that the project meets the required ethical standards and aligns with the ethical guidelines outlined by Assam Down Town University.

This Ethical Clearance Certificate confirms that the project has obtained ethical clearance and is approved to proceed with its implementation and data collection activities.

Date:

_____

Mr. Bhubneswar Das

Assistant Proffesor, Faculty of Computer Technology

Assam Down Town University

Panikhaiti, Guwahati-781026

CERTIFICATE FROM THE GUIDE

This is to certify that I, Mr. Bhubneswar Das has supervised and guided the final year Bachelor of Computer Applications (BCA) project entitled "SMART PARKING SYSTEM USING IOT" carried out by BIPASHA GOSWAMI with ADTU/2020-23/BCA/006, GUNJAN ROY with ADTU/2020-23/BCA/009 and TARIFA AHMED with ADTU/2020-23/BCA/024.

I have closely monitored and provided guidance to the students throughout the duration of their project. I have reviewed their project proposal, monitored their progress, and provided valuable inputs and suggestions to ensure the successful completion of their project.

I have thoroughly evaluated their project documentation, source code, and their presentation, and I am pleased to state that the project meets the expected standards and objectives set for the final year BCA project.

I, therefore, endorse and recommend the acceptance and approval of this project for the fulfillment of the Bachelor of Computer Applications degree from Assam Down Town University.

Date:

_____

Mr. Bhubneswar Das
Assistant Professor, Faculty of Computer Technology
Assam Down Town University
Panikhaiti, Guwahati-781026

CERTIFICATE FROM EXTERNAL EXAMINER

This is to certify that I, [External Examiner Name], have served as the external examiner for the final year Bachelor of Computer Applications (BCA) project entitled "SMART PARKING SYSTEM USING IOT" carried out by BIPASHA GOSWAMI with ADTU/2020-23/BCA/006, GUNJAN ROY with ADTU/2020-23/BCA/009 and TARIFA AHMED with ADTU/2020-23/BCA/024.

I was invited to evaluate and assess the project as an external expert in the field of computer applications. I have carefully examined the project documentation, source code, and the students' presentation.

Based on my assessment, I am pleased to state that the project demonstrates a commendable level of technical expertise, originality, and relevance to the field of computer applications. The students have showcased a strong grasp of the subject matter and have effectively applied their knowledge and skills in executing their project.

I have thoroughly evaluated the project against the set criteria and standards, and I am satisfied that the project meets the requirements for the successful completion of the final year BCA project.

I, therefore, endorse and recommend the acceptance and approval of this project for the fulfillment of the Bachelor of Computer Applications degree from Assam Down Town University.

Date:

_____

External Examiner

DECLARATION

We, BIPASHA GOSWAMI with ADTU/2020-23/BCA/006, GUNJAN ROY with ADTU/2020-23/BCA/009 and TARIFA AHMED with ADTU/2020-23/BCA/024, hereby declare that the final year Bachelor of Computer Applications (BCA) project entitled "SMART PARKING SYSTEM USING IOT" is the result of our own original work.

We affirm that the project has not been submitted for the fulfillment of any other degree or diploma program. The work presented in this project is authentic, and all experiments, results, findings, and conclusions are genuine and valid.

We declare that the project has been developed in accordance with the guidelines and regulations provided by the Assam Down Town University and the respective department. The project work has been carried out under the supervision and guidance of Mr. Bhubneswar Das, who has provided valuable support and direction throughout the project's duration.

I understand that this project may be subject to evaluation and examination by the project committee, external examiners, and any other authorized personnel involved in the assessment process.

By signing this declaration, I affirm my commitment to academic integrity and acknowledge that any violation of the aforementioned principles will be dealt with according to the rules and regulations of Assam Down Town University.

Place: Guwahati
Date:
Team members:

BIPASHA GOSWAMI _____
GUNJAN ROY _____
TARIFA AHMED _____

ACKNOWLEDGMENT

We would like to express our heartfelt gratitude and appreciation to all those who have contributed to the successful completion of our final year Bachelor of Computer Applications (BCA) project entitled “SMART PARKING SYSTEM USING IOT”.

First and foremost, we extend our deepest thanks to Mr. Bhubneswar Das, our project guide, for his invaluable guidance, continuous support, and expert supervision throughout the project.

We are grateful to the faculty members of Faculty of Computer Technology for their teachings, which laid a strong foundation for our academic and technical growth. We extend our thanks to the administration and staff of Assam Down Town University for providing the necessary resources and a conducive learning environment.

We are immensely thankful to the staff of ADTU Library for their exceptional resources and services.

We would like to express our sincere appreciation to our classmates and friends for their constant motivation, constructive discussions, and willingness to lend a helping hand whenever needed. We are thankful to our family for their unwavering belief in our abilities and their unconditional support throughout our academic journey.

Lastly, we would like to express our gratitude to all the authors, researchers, and developers whose works, publications, and open-source contributions have served as valuable references and inspiration for my project.

We acknowledge that without the collective support and encouragement from all these individuals and entities, this project would not have been possible.
Thank you.

ABSTRACT

The increasing urbanization and the rapid growth of vehicle ownership have led to a critical challenge in finding parking spaces in congested cities. To address this problem and giving the drivers a hassle free parking experience the system Smart Parking System Using IOT technology has been developed. The proposed smart parking system utilizes IoT sensors and communication technologies to collect real-time parking data. These sensors are deployed in parking lots to detect the availability of parking spots. The collected data is then transmitted to a centralized system, which processes and analyzes it to provide valuable insights to both drivers and parking management authorities. User can access these data about available parking slots by using our mobile application. Also our app will navigate the user to the selected parking lots. The implementation of a smart parking system using IoT technology brings numerous benefits. It reduces the time and effort spent by drivers in searching for parking spaces, minimizing traffic congestion and carbon emissions. Additionally, the integration of IoT enables efficient monitoring and maintenance of parking infrastructure, ensuring a smooth parking experience for users. In conclusion, the smart parking system presented in this abstract leverages IoT to revolutionize parking management by providing real-time data, convenience for drivers, and enhanced efficiency for parking authorities. By embracing such innovative solutions, cities can tackle the parking challenges posed by urbanization and create smarter, sustainable environments for their residents.

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CHAPTER 1

INTRODUCTION

In recent years, the rapid increase in urbanization has posed numerous challenges, one of which is the growing problem of finding parking spaces in crowded areas. This issue often leads to traffic congestion, wasted fuel, and increased pollution. To address this problem, our project focuses on developing a Smart Parking System using the Internet of Things (IoT) technology. It utilizes a network of connected sensors, a centralized server, and a user-friendly mobile application to provide real-time parking information.

By integrating IoT devices and centralized server, this system offers a comprehensive solution for optimizing parking space utilization and transforming the way drivers find and access parking spaces.

1.1 OVERVIEW OF THE PROJECT

The Smart Parking System using IoT aims to develop an efficient parking management system for crowded urban areas. By leveraging Internet of Things (IoT) technology, the project focuses on optimizing parking space utilization and enhancing the overall parking experience.

The system comprises IoT devices such as Sensors, Microcontroller, Gateways, and a Centralized Server. Sensors are installed in parking lots to collect real-time data on occupancy, which is transmitted to the server through gateways. This enables up-to-date information on parking availability.

A user-friendly mobile application is developed to provide drivers with real-time parking information. The app will show available parking slots of various parking lots of various cities. Users can search for their city and can select desired parking lot.

The system is scalable, with the ability to expand for larger parking lots or multiple facilities. A centralized server efficiently manages connected devices, ensuring seamless integration and scalability.

1.2 MOTIVATION

The motivation for developing the Smart Parking System using IoT is driven by the following factors:

Traffic congestion: The project aims to alleviate traffic congestion caused by drivers searching for parking spaces in crowded urban areas.

Optimal space utilization: By utilizing IoT devices, the system strives to optimize parking space usage and minimize wasted space.

User convenience: The project focuses on enhancing user convenience by providing real-time parking availability information through a user-friendly mobile application.

Sustainable urban development: The system contributes to sustainable development by reducing traffic congestion, carbon emissions, and improving air quality.

Technological innovation: Leveraging IoT technology, the project demonstrates the potential of IoT in solving real-world problems and improving urban living.

In summary, the Smart Parking System using IoT is motivated by the need to address traffic congestion, optimize parking space usage, enhance user convenience, promote sustainable development, and showcase technological innovation in urban environments.

1.3 SCOPE & OBJECTIVE

1.3.1 SCOPE

There are some online portals that provide information about parking areas in several countries. Those existing system only can give information about parking areas but not the information about how many parking slots are available or occupied. But our system will provide real time information about parking areas along with available parking spots. User can select the various parking lots available in the city and gain information about available or occupied parking spots in that selected parking lot.

We based our system on all over Assam tier 1 cities. At present there are no system in anywhere which can give parking lots information about almost all populated cities in a

state. Through our application user can select whichever city he is on and locate a parking lot and can see is there any parking spot is available or not.

Along with parking spot information our application will provide direction to the user for the particular parking lot. Our application will navigate the user to the parking spot he has selected.

1.3.2 OBJECTIVE

The main objective of the Smart Parking System using IoT is to develop an application which will provide real time information about parking slots in a specific parking lot in a selected city. The sub objectives of this system using IoT technology is to revolutionize the traditional parking management approach and provide a more efficient, convenient, and sustainable solution. The key objectives of the system include:

Parking Optimization: This system let users to get the best spot available reducing their valuable time, efforts and resources.

Reduce Traffic Congestion: This system helps user to quickly find available parking spots and aims to reduce traffic congestion.

Enhance User Experience: The system aims to enhance the overall parking experience for users. This includes providing a user-friendly mobile application that enables easy access to real-time parking information about vacant or occupied parking slots.

Sustainable Urban Development: The system supports sustainable urban development by reducing traffic congestion, minimizing unnecessary vehicle circulation, and promoting efficient space utilization. This contributes to improved air quality and reduced carbon emissions.

Reduce Management Cost: The system helps to reduce labour cost through optimized space utilization, automated processes and reduced traffic congestion. Overall, it offers increased efficiency and streamlined operations, resulting in cost savings.

Technological Innovation: The project aims to showcase the capabilities of IoT technology in solving real-world problems and improving urban living. It demonstrates the integration of IoT devices, data and mobile applications to create a smart parking management system.

In conclusion, the scope of the Smart Parking System using IoT project encompasses the development of a scalable and adaptable parking management system. The objectives focus on improving parking efficiency, enhancing the user experience, optimizing space utilization, supporting sustainable urban development, cost saving and showcasing technological innovation.

1.4 EXISTING SYSTEM

The existing system for the Smart Parking System using IoT project refers to the traditional or conventional parking management systems commonly found in urban areas. These systems typically involve manual processes, limited information availability, and lack real-time monitoring capabilities. Some key characteristics of the existing system include:

Manual Parking Management: The traditional system relies heavily on manual processes for managing parking spaces. This includes physical attendants or parking operators to monitor occupancy and guide vehicles.

Limited Information Availability: Drivers often lack accurate and up-to-date information about parking availability in the existing system. This results in a significant amount of time wasted searching for parking spaces, leading to traffic congestion and frustration.

Lack of Real-time Monitoring: The existing system lacks real-time monitoring capabilities, making it difficult to track parking occupancy and provide accurate information to drivers. This can lead to inefficient space utilization and an inability to respond promptly to changing parking demands.

Inconvenient User Experience: Drivers often face a cumbersome and time-consuming process of finding parking, interacting with attendants. This negatively impacts the overall user experience and satisfaction.

Limited Integration with Technology: The existing system generally lacks integration with modern technologies such as IoT and mobile applications. This limits the ability to leverage advanced features like real-time data about the parking lots.

The limitations and inefficiencies of the existing system highlight the need for the Smart Parking System using IoT. By introducing IoT devices, real-time monitoring, and a user-friendly mobile application, the project aims to overcome these shortcomings and revolutionize the parking experience for drivers and parking operators.

1.5 PROBLEM DEFINITION

The problem addressed by the Smart Parking System using IoT technology is the inefficiency and inconvenience associated with parking in crowded urban areas. The existing parking management systems lack real-time information, resulting in wasted time, increased traffic congestion, and poor space utilization. Manual processes, and limited integration with technology further contribute to a suboptimal parking experience for both drivers and parking operators.

The Smart Parking System using IoT project aims to address these problems by implementing IoT devices, real-time monitoring, and a user-friendly mobile application. By providing accurate parking information, streamlining the parking process, and enhancing the user experience, the project aims to revolutionize the way parking is managed and accessed in urban areas.

1.6 PROPOSED SYSTEM

The proposed system that is Smart Parking System using IoT is an innovative solution that leverages IoT technology to optimize parking management in crowded urban areas. The system introduces real-time monitoring, and a user-friendly mobile application to enhance the overall parking experience for drivers and improve space utilization.

Key Features of the Proposed System:

IoT Devices: The system incorporates IoT devices such as sensors, microcontroller, gateways, and a centralized server. Sensors are installed in parking lots to monitor occupancy and transmit real-time data from microcontroller to the server through gateways.

Automated Entry Barrier: The system provides automated entry barrier system through vehicle detection by the IoT sensor.

Real-time Monitoring: The proposed system provides real-time monitoring of parking spaces, enabling drivers to access accurate and up-to-date information on parking availability. This helps reduce search time, traffic congestion, and frustration.

User-friendly Mobile Application: A user-friendly mobile application is developed as part of the system. The application provides drivers with real-time parking information, displaying the number of available parking spots in a selected parking lot.

Scalability and Adaptability: The system is designed to be scalable and adaptable to different parking environments. Additional sensors and gateways can be easily deployed to accommodate larger parking lots or multiple facilities within a city.

1.7 METHODOLOGY

In this project we are using two IR Sensors, a Servo Motor, a 16*2 LCD Display I2C an Arduino UNO and a Node MCU. One IR sensor is used in entry gate and another IR sensor is used in exit gate to detect the vehicle. The servo motor is used in the entry gate to open and close the gate according to the sensor data. The 16*2 LCD I2C Display is also placed in the entry gate to display the slot availability. All the IR Sensor, servo motor, LCD Display and Node MCU is connected to Arduino UNO with the help of jumper wires and breadboard. Power supply is provided to both Arduino UNO and Node MCU.

Arduino UNO collects all data about the slot availability and sends it to the Node MCU. Node MCU collects the data sent by Arduino UNO and process it. Node MCU push the changing data to the Google Firebase Real Time Database. Firebase by Google stores the slot availability data.

In the mobile application with the help of Firebase Real Time Database, it displays the total number of available slot to the user by which user can easily park their vehicle to the respective parking lot if there parking slot is available.

Below is the architecture of our Smart Parking System using IoT.

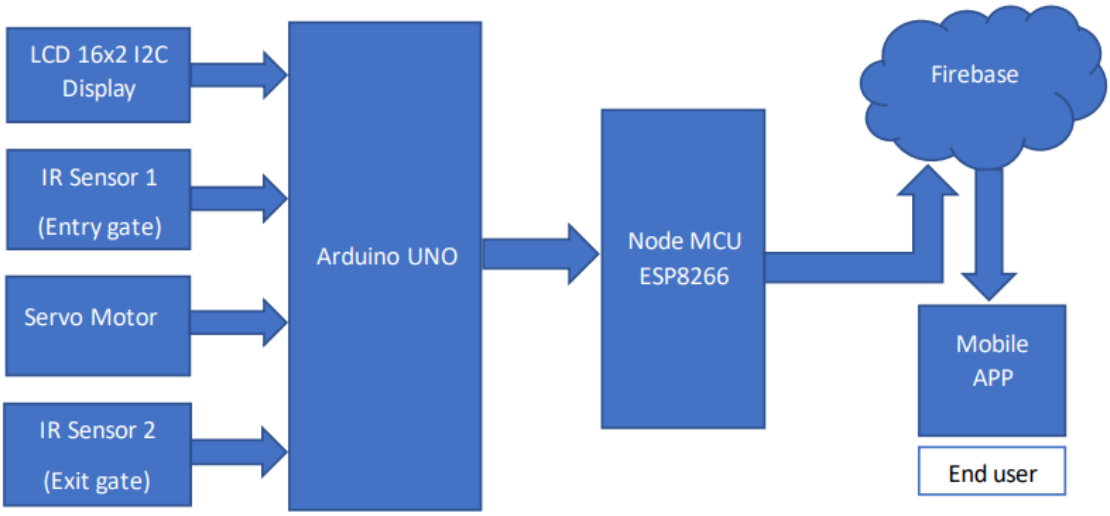

Fig 1.1 Architecture of Smart Parking System using IoT

CHAPTER 2

PROJECT ANALYSIS

2.1 PROJECT REQUIREMENT ANALYSIS

The purpose of this project requirement analysis is to outline the project requirements for developing a Smart Parking System using Internet of Things (IoT) technology. The system aims to provide an efficient and convenient parking experience by leveraging IoT devices and sensors to monitor and manage parking spaces in real-time.

2.1.1 SYSTEM OVERVIEW

The Smart Parking System will consist of the following key components:

a. IoT Devices: Sensors, actuators, and embedded systems deployed in parking spaces to monitor their occupancy status.

b. Communication Network: A robust and secure network infrastructure to facilitate seamless data transfer between the IoT devices and the central server.

c. Central Server: A cloud-based or on-premises server to process and analyse the data received from the IoT devices, and to manage parking space availability.

d. Mobile Application: A user-friendly interface for drivers to access real-time parking space information, and navigate to parking lot.

2.1.2 FUNCTIONAL REQUIREMENT:

The Smart Parking System must fulfill the following functional requirement.

Real-time Occupancy Monitoring: IoT devices should accurately detect the occupancy status of parking spaces and update the central server in real-time. The system should be capable of handling a large number of parking spaces and provide instantaneous updates to the users.

2.1.3 NON-FUNCTIONAL REQUIREMENT

The Smart Parking System must also meet the following non-functional requirements.

a. Scalability and Performance: Accommodate a large number of spaces and users without performance issues.

b. Security and Privacy: Encrypt communication and securely store user data.

c. Reliability and Availability: Ensure continuous system operation with redundant servers and backup mechanisms.

d. User Experience: Intuitive and user-friendly mobile application interface.

2.2 GANTT CHART

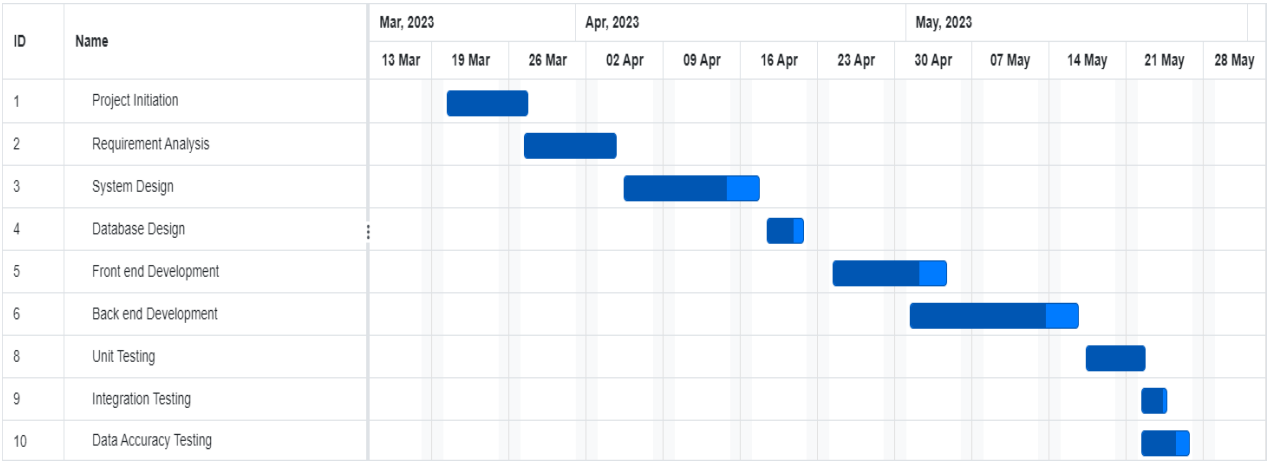

Chart 2.1 Gantt Chart for Smart Parking System

2.3 ADVANTAGE & DISADVANTAGE

2.3.1 ADVANTAGE

Here are the advantages of Advantages of the Smart Parking System using IoT:

Improved Parking Efficiency: The system provides real-time information on parking availability, reducing search time and congestion. Drivers can quickly locate and access vacant parking spaces, leading to efficient space utilization.

Enhanced User Experience: The user-friendly mobile application offers convenience by providing real-time parking information. Drivers can easily plan and navigate their parking experience, improving satisfaction.

Optimal Space Utilization: By leveraging real-time data, the system optimizes parking space allocation, reducing wasted resources and maximizing revenue generation for parking operators.

Reduced Traffic Congestion: With accurate parking information and efficient utilization of available spaces, the system helps reduce unnecessary vehicle circulation and traffic congestion in urban areas, contributing to smoother traffic flow.

Sustainability and Environmental Benefits: By minimizing vehicle circulation and congestion, the system reduces fuel consumption, air pollution, and carbon emissions, promoting environmental sustainability and healthier cities.

2.3.2 DISADVANTAGE

Here are the disadvantages of the Smart Parking System using IoT:

Initial Implementation Costs: Implementing the IoT infrastructure, including sensors, microcontroller and gateways, may involve initial high costs for hardware procurement, installation, and system development.

Technology Dependence: The system relies on the stability and reliability of IoT devices, connectivity, and the centralized server. Any technical issues, network disruptions, or server failures could impact the functionality of the system.

Data Privacy and Security Risks: Collecting and processing real-time data from sensors and user information through the mobile application may pose potential risks to data privacy and security. Robust security measures and compliance with data protection regulations are essential.

User Adoption and Accessibility: Not all users may have access to smartphones or be comfortable using mobile applications. Ensuring inclusivity and providing alternative means for accessing parking information is necessary.

Maintenance and Upkeep: The system requires regular maintenance, software updates, and monitoring to ensure optimal performance. This may involve additional costs and resources for system administrators and technical support.

Dependency on Power and Internet Connectivity: The proper functioning of IoT devices and the system relies on a stable power supply and internet connectivity. Power outages or network disruptions can temporarily impact the system's functionality.

It is important to consider these advantages and disadvantages when implementing the Smart Parking System using IoT, and to address any challenges proactively to ensure a successful and sustainable deployment.

2.4 PROJECT LIFE CYCLE

The project life cycle of the Smart Parking System using IoT can be divided into several key phases:

Project Initiation: Define project objectives, assess feasibility, and form the project team.

Requirements Gathering: Collect and prioritize system requirements.

System Design: Create the system architecture, design user interfaces, and determine hardware and backend infrastructure needs.

Development: Implement the smart parking system, including frontend interfaces, hardware integration, and backend infrastructure.

Testing and Quality Assurance: Conduct comprehensive testing.

Deployment and Release: Prepare the system for deployment.

This brief overview captures the main phases of the project lifecycle for a smart parking system, ensuring a structured approach to its development and deployment.

2.5 PROJECT FEASIBILITY STUDY

The feasibility study for the Smart Parking System using IoT aims to evaluate the viability and potential success of the project. It assesses various factors, including technical feasibility, economic viability, and operational practicality. Here is an overview of the feasibility study:

Technical Feasibility: Evaluate the technical requirements and capabilities of implementing an IoT-based parking system. Assess the availability and compatibility of IoT devices, sensors, microcontroller, gateways, and communication protocols. Analyse the infrastructure requirements for deploying and maintaining the system, including server capacity and connectivity.

Economic Feasibility: Estimate the project costs, including hardware procurement, software development, installation, and maintenance. Consider the long-term economic benefits, such as increased revenue from efficient parking utilization and reduced operational costs. Operational Feasibility: Analyse the practicality of implementing and managing the smart parking system. Assess the availability of skilled personnel and resources required for system deployment, operation, and maintenance. Consider the impact on existing parking operations and the feasibility of integrating the new system into the current infrastructure.

Legal and Regulatory Feasibility: Identify and evaluate any legal and regulatory requirements or restrictions related to implementing the smart parking system. Ensure compliance with data privacy regulations, security standards, and any relevant local or national laws.

Environmental and Social Feasibility: Assess the potential environmental benefits of reducing traffic congestion and air pollution through efficient parking management. Consider the social impact of the system on improving the overall parking experience,

reducing frustration, and enhancing convenience. Based on the findings of the feasibility study, we can make informed decisions regarding the implementation of the Smart Parking System using IoT. The study helps identify potential challenges, risks, and benefits, allowing for adjustments to the project plan and ensuring its overall viability and success.

CHAPTER 3

PROJECT DESIGN

The project design for the smart parking system using IoT includes a system architecture comprising smart sensors, a communication network, and a centralized backend system. Smart sensors are deployed in parking spaces to detect occupancy, and a communication network enables real-time data transmission to the backend system. The backend system consists of modules such as data processing, a database and user interface. The design emphasizes integration with other smart city infrastructure, security and privacy measures, and a user-friendly experience. It provides a roadmap for the development and implementation of the smart parking system.

3.1 CONTEXT DIAGRAM

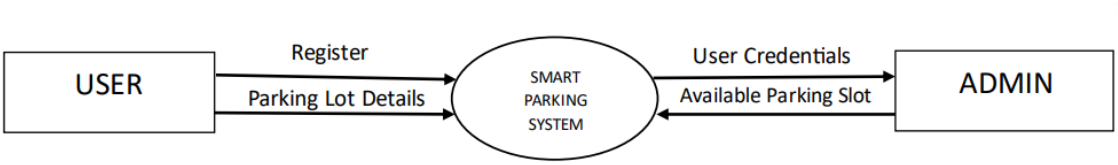

Fig 3.1 Context Diagram for Smart Parking System

3.2 ENTITY-RELATIONSHIP DIAGRAM

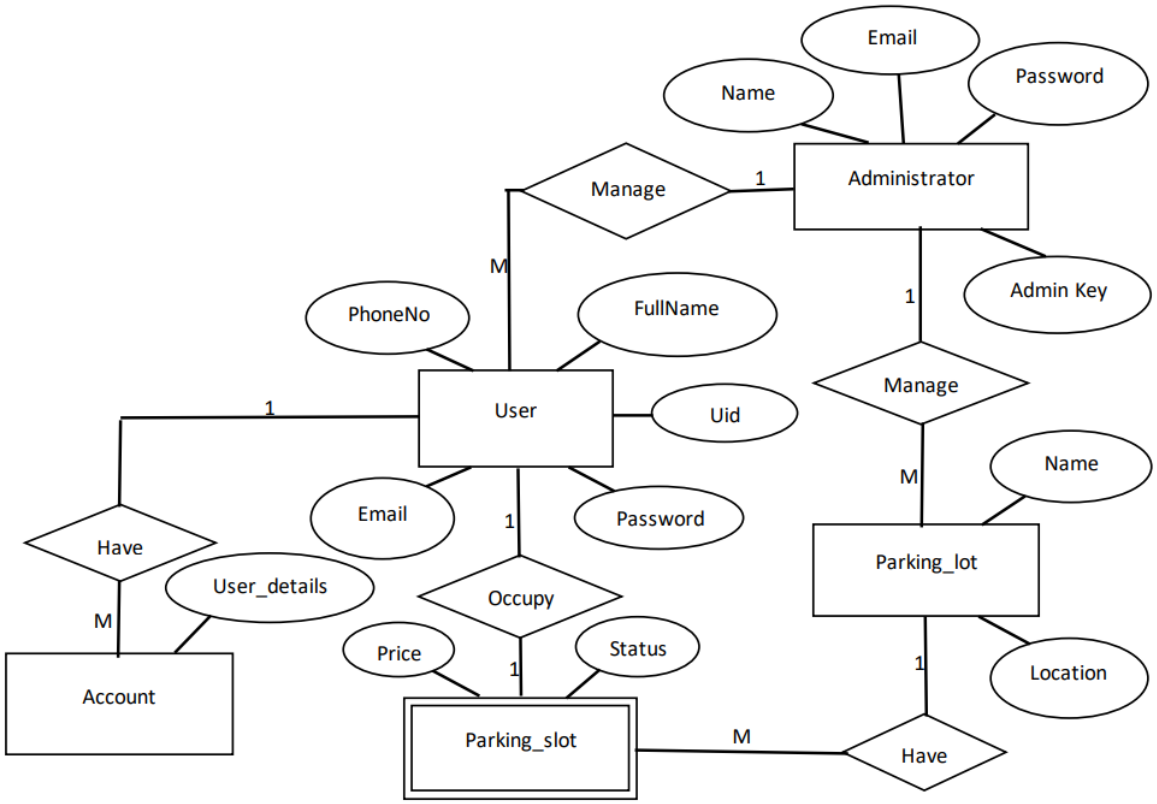

Fig 3.2 ER Diagram for Smart Parking System

3.3 SEQUENCE DIAGRAM

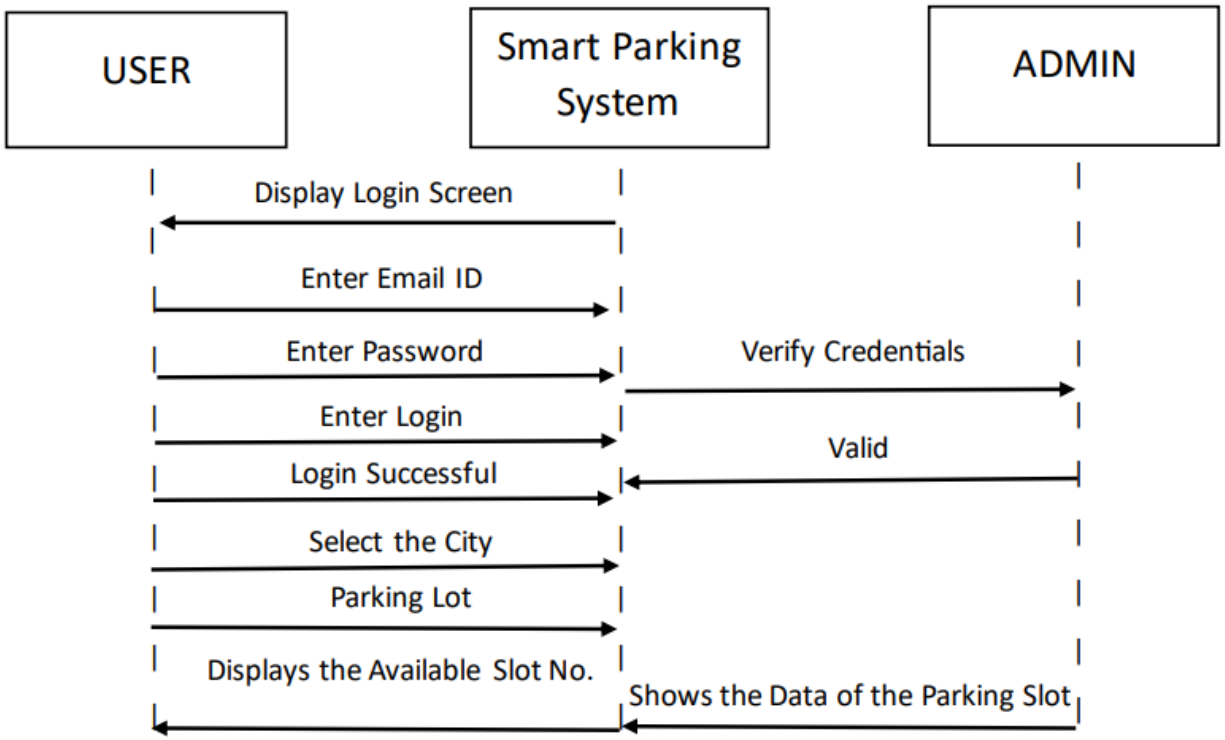

Fig 3.3 Sequence Diagram for Smart Parking System

CHAPTER 4

PROJECT IMPLEMENTATION

The project implementation for the smart parking system using IoT involves developing the necessary hardware and software components.

4.1 DESCRIPTION OF THE HARDWARE USED

A smart parking system typically involves the integration of various hardware components to effectively manage and monitor parking spaces.

4.1.1 IR SENSOR

An infrared (IR) sensor detects infrared radiation emitted by objects. It consists of an emitter and a receiver. The emitter emits IR radiation, which is reflected or absorbed by objects. The receiver converts the received radiation into an electrical signal. This signal is processed to determine the presence or absence of objects. IR sensors are used in proximity detection, object counting, remote control systems, flame detection, and motion detection.

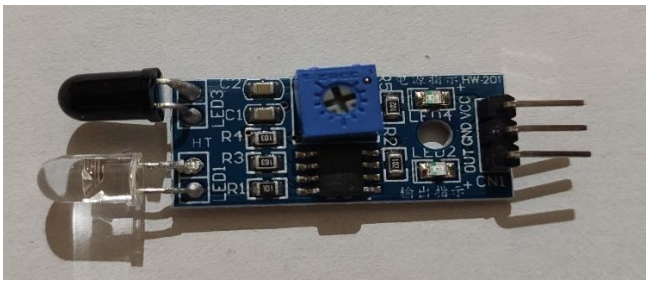

Fig 4.1 IR Sensor

4.1.2 Servo Motor

A servo motor is a type of rotary actuator that allows for precise control of angular position, speed, and acceleration. It is an electromechanical device that converts electrical

signals into mechanical movement. Servo motors are commonly used in applications that require accurate and controlled motion.

Fig 4.2 Servo Motor

4.1.3 LCD Display 16*2 I2C

An LCD 16x2 display with I2C is a compact and easy-to-use liquid crystal display that features 16 columns and 2 rows of characters. The I2C interface simplifies communication with the display using only two wires, making it convenient for microcontroller connections. It is commonly used for text-based displays in various applications.

Fig 4.3 16*2 LCD Display

4.1.4 Arduino UNO

Arduino UNO is a popular open-source microcontroller board based on the ATmega328P microcontroller. It has a simple and user-friendly programming environment and offers various input/output pins for connecting sensors and actuators.

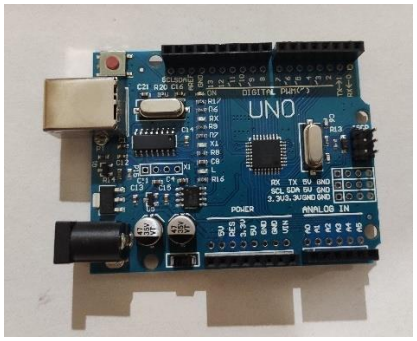

Fig 4.4 Arduino UNO

4.1.5 Node MCU ESP8266

Node MCU ESP8266 is an open-source development board for IoT projects which acts as an IoT gateway. It provides entrance to Arduino UNO or any other microcontroller to Wi-Fi network connectivity which support 2.4GHz Wi-Fi frequency band.

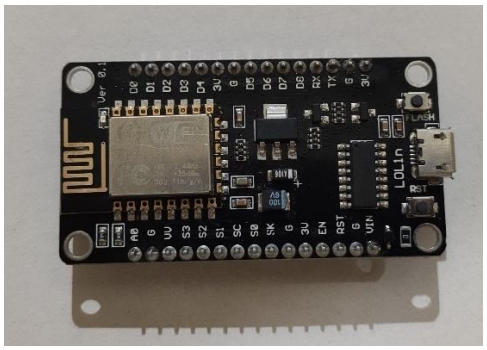

Fig 4.5 Node MCU ESP8266

4.1.7 Jumper Wires

Jumper wires are short wires with connectors on both ends used for making electrical connections between components on a breadboard or other electronic platforms. They are typically made of flexible insulated wire with connectors, such as male-to-male, male-to-female, or female-to-female, at each end.

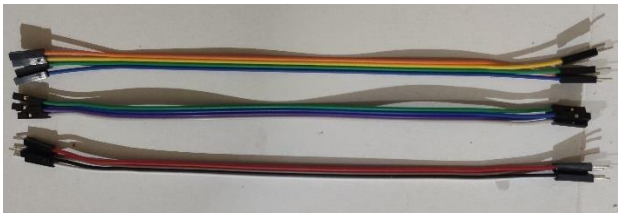

Fig 4.6 Jumper Wires

Overall, the hardware components used in a smart parking system work together to monitor parking availability, improve parking efficiency and enhance security.

Below diagram shows the pin diagram of our hardware model which consists of all the mentioned hardware.

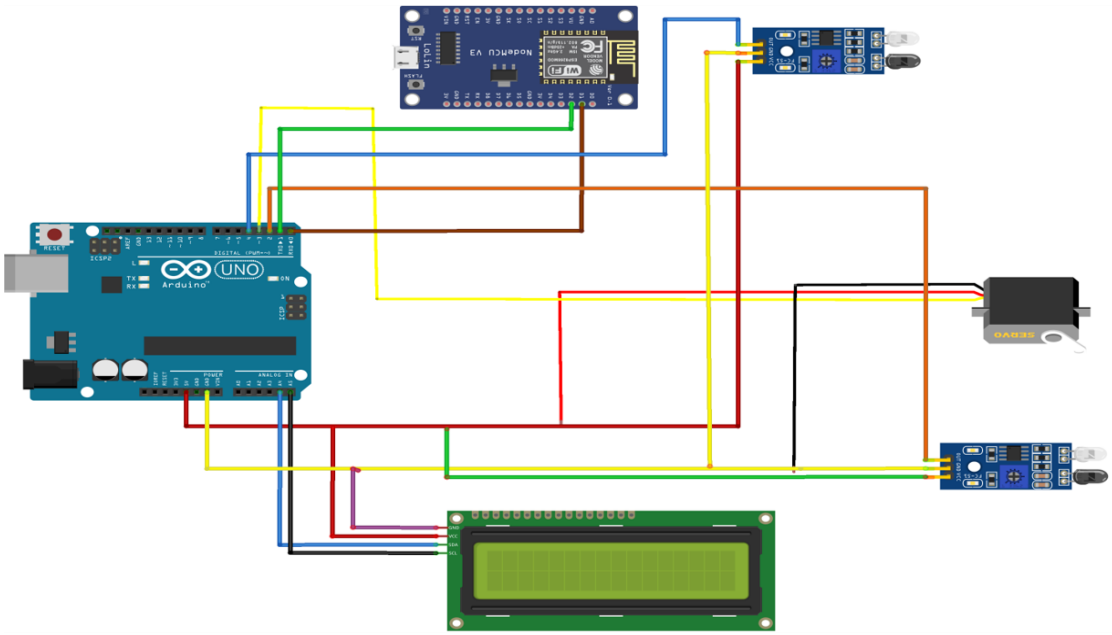

Fig 4.7 Pin Diagram of Hardware Model

4.2 DESCRIPTION OF THE SOFTWARE USED

4.2.1 Arduino IDE

Arduino IDE, short for Arduino Integrated Development Environment, is a software platform designed for programming and developing applications for Arduino boards. It serves as the primary tool for creating, editing, and uploading code to Arduino microcontrollers.

The Arduino IDE provides a user-friendly interface that simplifies the process of writing code and uploading it to Arduino boards. It is compatible with various operating systems such as Windows, Mac, and Linux, making it accessible to a wide range of users.

The IDE offers a robust code editor with features like syntax highlighting, auto-completion, and error checking, which help developers write code efficiently and identify potential issues. It supports the Arduino programming language, which is based on a simplified version of C++.

In addition to code editing, the Arduino IDE allows users to manage libraries, which are collections of pre-written code that can be easily incorporated into projects. It provides a built-in library manager for convenient installation and updates.

Once the code is written, the Arduino IDE enables users to upload it to Arduino boards via a USB connection. It handles the compilation and transfer of the code to the target board, making it ready to execute the desired functionality.

4.2.2 Android Studio

Android Studio is an integrated development environment (IDE) designed specifically for creating Android applications. It provides developers with a comprehensive set of tools and features to streamline the app development process. Android Studio offers a user-friendly interface and a powerful code editor, making it the go-to choice for Android app development.

The IDE is built on top of the IntelliJ IDEA platform, providing a robust and efficient environment for writing code. It supports various programming languages, including Java and Kotlin, which are widely used for Android development. Android Studio offers advanced code completion, debugging capabilities, and code refactoring tools, enhancing developers' productivity and helping them write clean and efficient code.

One of the key features of Android Studio is the Android Emulator, which allows developers to test their apps on virtual devices with different screen sizes, resolutions, and Android versions. This helps ensure that the app functions correctly on a wide range of devices before releasing it to users.

Android Studio also provides a visual layout editor, enabling developers to design app interfaces using drag-and-drop functionality. This simplifies the process of creating user interfaces and allows for real-time previews of how the app will appear on different devices.

Additionally, Android Studio integrates with the Android Software Development Kit (SDK) and offers seamless integration with various tools and libraries. It supports version control systems like Git, allowing for collaborative development. The IDE also provides performance analysis tools, memory profiling, and support for building different types of apps, such as mobile, wearable, and Android TV applications.

In summary, Android Studio is a comprehensive IDE specifically designed for Android app development. It offers a wide range of features, tools, and resources to help developers build high-quality and efficient Android applications.

4.2.3 Google Firebase

Google Firebase is a comprehensive mobile and web application development platform that provides developers with a set of tools and services to build, deploy, and scale their applications efficiently. Firebase offers a wide range of features, including authentication, real-time database, cloud messaging, hosting, and more, making it a popular choice for app developers.

One of the key components of Firebase is Firebase Authentication, which provides secure user authentication and authorization for apps. It supports various authentication methods, including email/password, social media sign-in, and phone number authentication, allowing developers to quickly implement user authentication functionality without compromising security.

Firebase Realtime Database is another essential feature that offers a flexible and scalable NoSQL database in the cloud. It allows real-time synchronization of data between clients and provides offline capabilities, enabling users to access and modify data even when offline. This makes it ideal for applications that require real-time updates, such as chat apps or collaborative tools.

Firebase Cloud Messaging (FCM) enables developers to send push notifications to their app users, keeping them engaged and informed.

Firebase Hosting provides developers with a secure and scalable hosting solution for their web applications.

Additionally, Firebase offers a suite of other services, including Firebase Cloud Firestore (a scalable and flexible NoSQL document database), Firebase Cloud Functions (serverless compute platform for running backend code), Firebase Performance Monitoring (to monitor app performance and gain insights), Firebase Remote Config (to remotely configure app behaviour), and more.

One of the key advantages of Firebase is its seamless integration with other Google Cloud Platform services, allowing developers to leverage additional cloud resources as their app scales. Firebase provides a simple and intuitive interface, SDKs for multiple platforms and languages, and extensive documentation and support, making it an attractive choice for both beginner and experienced developers.

4.3 UI (MODULE WISE)

Below is the flowchart of the mobile application and explanation of each step which driver needs to follow in order to park his/her car, through user interface (module wise) pictures of our mobile application.

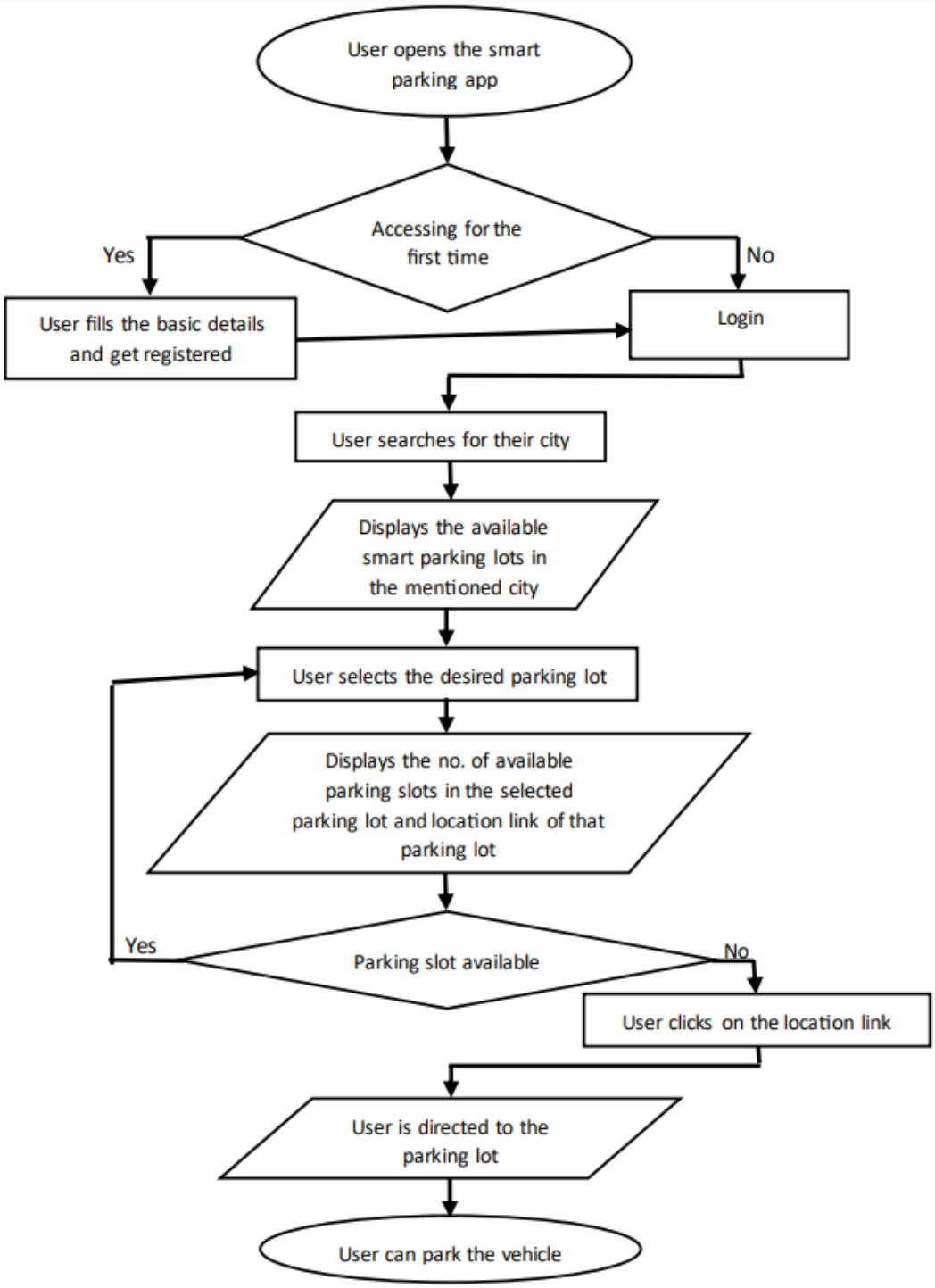

Fig 4.8 Flowchart of The Mobile Application

Step 1: Open the smart parking mobile application on your mobile device.

Fig 4.9 Splash Screen (UI)

Step 2: a) If the user accessing for the first time he has to register by filling the basic details on the mobile app.

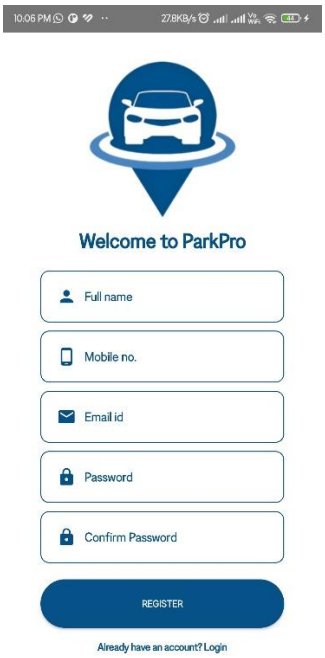

Fig 4.10 Register Screen (UI)

b) If the user is already register he has to login by filling email id and password on the mobile app.

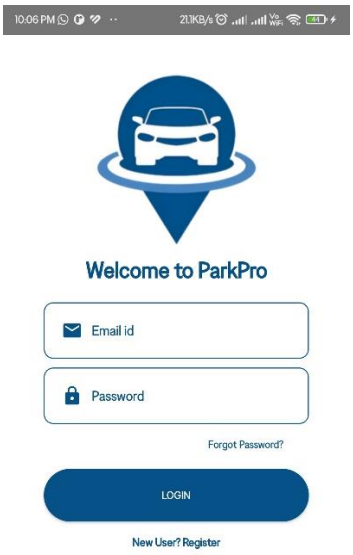

Fig 4.11 Login Screen (UI)

Step 3: After successful login, users can search for their city.

Fig 4.12 Cities Screen (UI)

Step 4: The parking lots available in that selected city is displayed. Now user can select their desired on nearby parking lot.

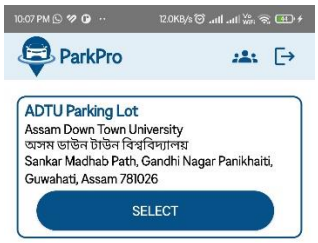

Fig 4.13 Parking Lot Screen (UI)

Step 5: The number of available parking slots in the selected parking lot and direction link of that lot are displayed.

Fig 4.14 Available Parking Slots and Direction Link Screen (UI)

Step 6: If there are available parking slots user can click on the direction link to navigate to the destination.

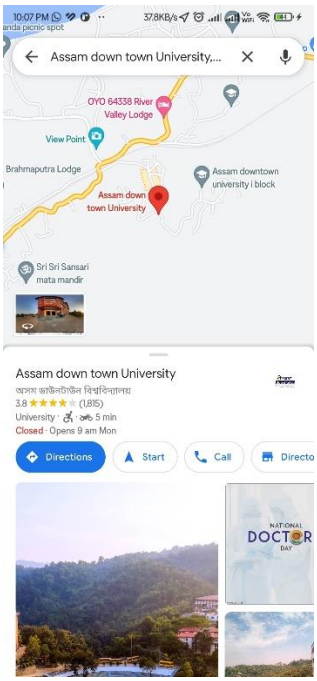

Fig 4.16 Direction Screen (UI)

CHAPTER 5

TESTING ANALYSIS

5.1 TYPES OF TESTING

For the smart parking system using IoT, several types of testing are conducted to ensure its quality and reliability. Here are the key types of testing performed in this project:

Unit Testing: This type of testing focuses on testing individual components of the system, such as sensors, communication network modules, backend system modules, and the mobile application. It ensures that each component functions correctly and performs as expected.

Integration Testing: Integration testing involves testing the integration and interaction between different components of the system. It ensures that the communication between sensors, the backend system, and the mobile application is seamless and that data is transmitted accurately.

Data Accuracy Testing: This testing focuses on verifying the accuracy of parking space occupancy detection. It compares the sensor data with the actual status of parking spaces to ensure that the system accurately detects and updates the availability of parking spots.

By conducting these various types of testing, the smart parking system can be thoroughly evaluated, ensuring its functionality, performance, accuracy and usability under different scenarios.

5.2 TEST CASES

In the following different cases are explained with the pictures.

Case One

This case shows that all the parking spaces in the parking lot are vacant. So, it will allow vehicles to park into the lot. Therefore the 16*2 LCD displays the number of slot left on the parking lot. Similarly it displays the same result in the mobile application also.

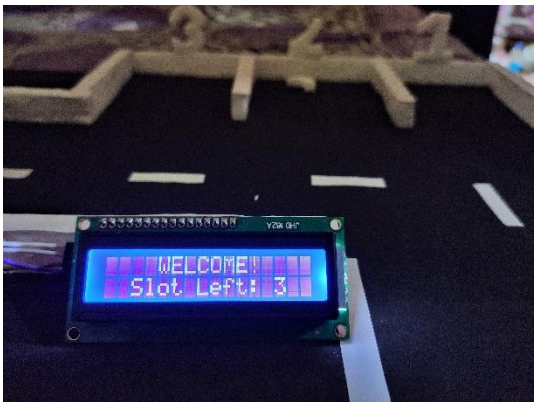

Fig 5.1 LCD Display View Case One

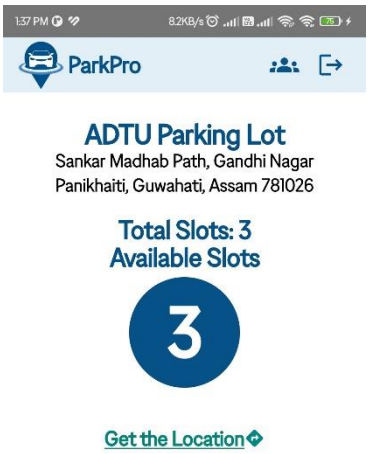

Fig 5.2 Mobile App View Case One

Case Two

This case shows user can go to the parking lot using the direction on the mobile app. After parking the vehicle, the 16*2 LCD displays the number of slot left which will decreased by one as the user park the vehicle. Similarly it displays the same result in the mobile app.

Fig 5.3 LCD Display View Case Two

Fig 5.4 Mobile App View Case Two

Case Three

This case shows when all the parking spaces are occupied, the 16*2 LCD displays the parking full message. Similarly it displays the result as zero in the mobile app.

Fig 5.5 LCD Display View Case Three

Fig 5.6 Mobile App View Case Three

Case Four

This case shows if a car goes out from the parking lot, the 16*2 LCD displays the number of slot left which will increased by one as a car is removed from the parking lot. Similarly it displays the same result in the mobile app also.

Fig 5.7 LCD Display View Case Four

Fig 5.8 Mobile App View Case Four

CHAPTER 6

CONCLUSION & FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the development and implementation of the smart parking system using IoT for our final year project have been a success. We have designed and deployed a solution that addresses the ever-growing parking challenges in urban areas by leveraging the power of Internet of Things (IoT) technology. Through this project, we have demonstrated the feasibility and effectiveness of using IoT devices, sensors, and real-time data processing to optimize parking space utilization and enhance the overall parking experience.

By integrating various components such as smart sensors, communication networks, and user-friendly mobile applications, we have created a comprehensive smart parking system. Our system provides real-time information about parking space availability and provides direction to users searching for parking spots. Moreover, we have incorporated features like monitoring of available parking spots to enhance efficiency and security.

The successful implementation of our smart parking system not only benefits drivers by reducing the time spent searching for parking but also contributes to reducing traffic congestion, minimizing environmental pollution, and improving overall urban mobility. The project has provided us with valuable hands-on experience in IoT development, sensor integration, data management, and user interface design.

6.2 FUTURE SCOPE:

While our smart parking system has achieved its primary objectives, there is still significant potential for future enhancements and scalability. Here are a few areas that can be explored:

IoT Sensor Deployment: By installing IoT sensor in each parking slot which will help to provide data about each parking slot that is vacant and occupied, user can get the best available location.

Payment and Reservation System: By adding the features such as reserve a parking spot and payment for that spot in the mobile application can optimize smooth parking process.

Predictive analytics and machine learning: By leveraging historical parking data, machine learning algorithms can be applied to predict parking space availability based on various factors such as time, day, events, and weather conditions. This predictive capability can further optimize the parking experience for users.

Additional Machine Learning Algorithm: By applying Machine Learning Algorithm to store various types of data such as vehicle number, colour model etc which would add additional security.

Integration with electric vehicle charging infrastructure: As the adoption of electric vehicles increases, integrating our smart parking system with electric vehicle charging stations can promote sustainable transportation. Users will be able to locate available charging stations reducing range anxiety and encouraging the use of electric vehicles.

User feedback and rating system: Implementing a feedback and rating system within the mobile application would enable users to share their experiences, report issues, and provide suggestions for improvement. This feedback mechanism can help in continuously enhancing the system's performance and user satisfaction.

In conclusion, our smart parking system using IoT has laid the foundation for an intelligent and efficient parking infrastructure. The future scope of this project is vast, with opportunities to integrate with other smart city systems, apply advanced analytics, cater to electric vehicle charging, expand to different types of parking facilities, and incorporate user feedback. By continuing to innovate and refine our system, we can contribute to the development of smarter and more sustainable cities.

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